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PTO 03-2985

German Patent

Document No. 1 632 324

FUNNEL CENTRIFUGE

[Trichterzentrifuge]

Not named

UNITED STATES PATENT AND TRADEMARK OFFICE

Washington, D.C. May 2003

Translated by: Schreiber Translations, Inc.

Country	:	Federal Republic of Germany
Document No.	:	1 632 324
Document Type	:	Published patent application
Language	:	German
Inventor	:	Not named
Applicant	:	Gerhard Telle, Heidenheim, Federal Republic of Germany
IPC	:	B04B
Application Date	:	April 3, 1967
Publication Date	:	October 29, 1970
Foreign Language Title	:	**FUNNEL CENTRIFUGE**
English Title	:	Trichterzentrifuge

/1[1]

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Funnel Centrifuge

The invention concerns a centrifuge for separating and eliminating solids from mixtures of solids and liquids such as, for example, wastewater of community or industrial origin, sludge pulp, and suspensions that occur during the processing of foods and the like.

Centrifuges for this purpose are known, which have a vertically mounted rotor that has at least two funnel-shaped, diametrically-opposite settling tanks, whose mouths are equipped with a controllable shut-off device for the outlet opening. These centrifuges are called therefore for short funnel centrifuges.

/2

As a consequence of the constantly increasing industrialization, but also due to the constantly increasing population density in the communities, there are constantly greater quantities of

[1] Numbers in the margin indicate pagination in the foreign text.

wastewater, sludge pulp, and the like, for whose purification or dehydration the purification plants that work with naturally settling processes such as a settling basin, settling funnel, etc. are no longer sufficient. With them are obtained the best purification effects, but they work slowly and require settling surfaces at high throughflow rates with an extension that can generally no longer be made available.

Centrifuging, instead, offers the requisites for processing rapidly also greater amounts of wastewater or slime and the centrifuges have a relatively low surface or spatial requirement. However, with none of the centrifuges know until now could be achieved an application on a large scale at the level of the purifying effect of a purification plant relying on the natural settling process. Merely with so-called laboratory centrifuges were achieved satisfactory results with this respect.

It is therefore an object of the invention to create the requisites therefor so that also when centrifuging

/3

wastewater, sludge pulp, and the like are obtained purification effects that are no longer inferior to those of the natural purification plants. For this purpose was to be selected first among the known centrifuge designs a design that offers the best

requisites from the hydrodynamic as well as also from the constructional point of view. At this time resulted the surprising discovery that this design is the funnel-shaped centrifuge of the type described above, which had hardly been used until now in the purification practice and which, even in the documented state of the art, as is often commonly reflected in particular in the patent literature, had been discussed only to a very limited extent.

It is therefore an object of the invention to achieve a further development and improvement of these known funnel centrifuges with the goal of achieving greater throughput rates therewith with a high purification effect. This goal is achieved mainly by including the following features:

a) settling chambers comprised by a funnel-shaped end piece and a relatively extended cylindrical cone part with

/4

an inlet pipe arranged centrally in the cone part and passing through up to the end of this cone part or leading up to the vicinity of this end;

b) a partition of the annular-cylindrical hollow space formed between the inlet pipe and the inner wall of the cylindrical cone part into a multitude of parallel flow

channels through planar and/or bent conducting surfaces, partition walls, or the like; and

c) outlet openings of the funnel-shaped end pieces of the settling chambers, which can be continuously modified to closed in their average cross section.

Therefore, the funnel centrifuge according to the invention has a multitude of counter-rotating flowed settling chambers, which correspond in their shape to the stationary settling funnels, in which however the mixture of materials to be treated is exposed at high flow speeds to a multiple of the gravitational acceleration g. To prevent turbulence in the flow and to achieve a uniform distribution of the fed mixtures of materials, the introduction takes place forcefully and precisely in the center of the settling chamber. Thereby, the mouth of the inlet pipe is arranged so far from the overflow zone of the clear fluid that

/5

the solids, despite the high throughflow speed, find sufficient time to separate from the liquid and travel toward the funnel tip. Between the cross section of the inlet pipe and that of the annular-cylindrical hollow space in the cone part of the settling chamber, is selected the ratio that results in a ratio between the inflow quantity and the discharge quantity, which

has as a consequence in the treated mixture of materials an advantageous separation settling speed for an optimal purification effect. With an annular-cylindrical hollow space, the settling chambers offer a constant purification volume as well as a constant purification surface and by partitioning this hollow space into a multitude of parallel flow channels is ensured a laminar and therefore predominantly turbulence-free throughflow. If the outlet openings of the funnel-shaped end piece can be continuously changed to closed in their average cross section of the settling chambers, then the discharge of eliminated solids can be continuously regulated with respect to their quantity and their concentration, which was not possible until now.

Further features of the funnel centrifuge of the invention and the advantages obtained therewith will be explained in more

/6

detail in the description of the exemplary embodiments shown in the attached drawings, wherein:

Fig. 1 shows a funnel centrifuge of the invention in a vertical section along line I-I of Fig. 2;

Fig. 2 shows the plan view on the centrifuge of Fig. 1, shown partially broken away.

The funnel centrifuge of the invention consists of a cylindrical, simple, and therefore economic housing 1 made of steel plate and section steel produced in welding construction with a jacket part 10, which is mounted on the floor with its annular-shaped bottom flange 12 via elastic bearings 13 of rubber-metal connection or the like and which has a head ring 14, with which the cover that is stiffened with radial ribs 15 can be detachably attached, which in turn carries the neck bearing 20 for the hollow shaft 2 of the rotor 3. The support bearing 21 of the shaft 2 is held centrally in the jacket part 11 of the housing 1 about at half height by means of radial arm bridges 16 of sheet metal. Between its two bearings 20 and 21, the shaft 2 carries the field spider 30, which is comprised of six settling chambers 33 formed by a pipe section, which have

/7

at their free end a mounting flange 34 on which the funnel-shaped end piece 4 is detachably fixed by means of its front flange 41. At its tip, the jacket part 40 of the funnel-shaped end piece 41 has another flange 42, which serves for mounting a discharge valve 45, which will be further discussed in the following. The field spider 30 is mounted on the shaft 2 with its head flange 31 and its foot flange 32.

In each of the six settling chambers 33 is seated centrally an inflow pipe 35, which is used in a connecting bore of the shaft 2 and is suitable screwed to be able to exchange the pipe if required against another one of different length. The connection with the axial core bore 23 is produced at the upper end by the connecting bore that ends in the shaft 2, at whose mouth a rotatable connecting flange 24 is used. The inflow pipe 35 is located with its mouth approximately in the plane of the flanges 34, on which the funnel-shaped end piece 4 is fixed. The annular-cylindrical space extending between the inflow pipe 35 and the inner wall surface of each settling chamber 33 is evenly partitioned by means of planar conducting surfaces into a multitude of parallel flow channels, and namely

/8

by radial walls 36, into six annular sectors, which in turn are again partitioned by three transverse walls 37, which are parallel to each other, into sections of about the same width, so that now rather the annular-cylindrical space of each settling chamber is represented in a cell structure of twenty four channels of about trapeze-shaped cross section.
With its area 38 that projects into the cone-shaped inner space of the funnel-shaped end piece 4, the radial walls 36 support a double cone-shaped drawbar 39 coaxially and somewhat centrally

between the mouth of the conducting pipe 35 and the mouth at the tip of the funnel-shaped end piece 4, while the drawbar 39 faces with its more slender cone part the mouth of the inflow pipe 35. The flow-conducting installation formed by the radial walls 36, 38, the transverse walls 37, and the drawbar 39, forms advantageously an independent structure that can be pushed as a unit onto the inflow pipe 35 and is advantageously made of plastic, which contributes to the weight reduction of the rotor and also contributes to the chemical resistance. The installation could also form a structural unit with the inflow pipe.

/9

For the discharge of the purified liquid are provided annular segment-shaped breakthroughs in the foot flange 32, which are concentric with respect to the shaft 2, and which correspond to respective breakthroughs 51 of a support and distribution disk 50, which is drawn up over the bond 25 located on the support bearing 21 of the shaft 2. The disk 50 establishes with its radial transverse bores 52 the connection between the conducting pipes 46 for feeding the pressurized means to the discharge valves 45 and corresponding transverse bores 27 in the shaft 2, which in turn are connected to the axial core bore 26 that ends at the lower end of the shaft 2.

Starting from the support and distribution disk 50, the lower part of the shaft 2 is concentrically enclosed by a cylindrical collection container 17, wherein the arm bridges 16 that support the support bearing penetrate through the container and support the same. Together with the bottom surface of the housing of the bearing 21, an annular-cylindrical collecting channel 18 forms together with the V-shaped cross section the bottom of the collecting channel 17 and from this collecting channel 18 leads a radial discharge pipe 19 out of the centrifuge housing.
At the end of the shaft 2 that projects from the bottom of the bearing 21 is fixed freely rotatable the control valve 47 that actuates the discharge valve 45. It is supported by a support

/10

plate 181 and encloses the hollow space formed by the collecting channel and the support bottom to prevent contamination by discharge of the solids that are collected from below the collecting container 17, 18 in the collecting funnel 101 arranged in the centrifuge housing 10 and are filled into collecting bins 102 that can be driven on guide rails 103.
The drive of the rotor 3 takes place by means of the electric motor 6 arranged by means of the tensioning device 60 on the side of the centrifuge housing and namely via the v-belt 61 surrounded by the protective hood 62 on the v-belt disk 63

screwed on the upper end of the shaft 2, which in turn is surrounded by its own protective hood 54 mounted on the bearing 20. A contamination of the drive parts by the discharged centrifuged product is likewise prevented.

For the funnel centrifuge according to the invention shown in Figs. 1 and 2 results the following mode of operation:

The mixture of the solids and liquid to be purified or to be separated (wastewater, sludge pulp, suspension) is introduced through a pipeline (which is not shown), if required under pressure at 24 into the core bore 23 of the shaft 2,

/11

from which it enters into the inflow pipe 35 of the six settling chambers 33 of the field spider 30, which is driven by the motor 6 with a rotational speed that is sufficient to provide the mixture with the required centrifugal acceleration for the desired throughput and purification rate. The mixture penetrates, which is a requirement for obtaining advantageous flow conditions in the settling chamber 33, and is drawn by the inflow pipes 35 up to the reversal area lying in the funnel-shaped end piece 40, so that between this area and the overflow zone results a liquid column of such length that a flawless separation and demixing is ensured. In the settling chamber 33 takes place a flawless hydraulic guidance of the mixture to be

treated. The space to be flooded has not only a cross section that remains the same, but via the provided conducting surfaces is also achieved a partition and erection of the liquid flow into the laminar partial flows and therefore a predominantly turbulence-free flow.

In the funnel-shaped end piece 4 settle the separated foreign substances and a thickening takes place at a solids sump, whose consistency can increase the selected funnel inclination in such a way that at the tip of the funnel even a kind of closure plug is formed,

/12

which supports the effect of the closure arrangement in a desired manner. It behooves to the drawbar 39 located ahead of the mouth of the inflow pipe 35 to prevent that the solids sump that forms at the tip of the funnel is not swirled again by the exiting liquid stream and it also contributes to the stabilization of the liquid flow.

The solids are extracted constantly or at specific intervals from the chambers 33 by the mouth of the funnel-shaped end piece 4 by means of the discharge valves 45 and guided via the collecting boxes 102 by the centrifuge. These discharge valves 45 have a pipe-shaped elastic insert 48 of rubber, plastic, or the like, which is acted on from outside, with the aid of

pressurized liquid in such a way that the throughput cross section reduces the throughflow by throttling or is completely suppressed. With these discharge valves, which are already known, it is only possible to achieve a constant discharge of solids in a funnel centrifuge, which also promotes the upward flow into the funnel part. This discharge can also be influenced with reference to the concentration of the solids portion and in this way the purification effect of the centrifuge

/13

can be varied, which allows an adaptation of the centrifuge to the processing conditions of different mixtures.

The pressurized medium that flows through the discharge valves 45 via the lines 46, 52, 27, and 26 is automatically controlled by the electropneumatic or electrohydraulic control device 49 that is installed suitably on the side of the centrifuge housing under the electric motor 6 according to a specific program selected with respect to the opening time, opening speed, the opening pressure, or the opening periods. The pasty or dough-like solids that exit via the valves 45 fall into the collecting funnel 101, from where they arrive in the collecting bins 103 of another device for discharging, for example, a screw extruder, a conveyor belt, or the like.

The liquid, which his being cleared, that flows from the funnel-shaped end piece 4 through the settling chambers 33 to the center of the rotor 3, exits from the field spider 30, through the openings 51, into the collecting chamber 17, wherein through the drop edge 53 of the support and distribution disk 50 is effected a centrifugation directed downward into the collecting channel 18, from which

/14

collecting channel the liquid is discharged through the pipe 19 to the outside.

As the test samples showed, the purification effects that can be obtained with the funnel centrifuge of the invention with a low construction expense and a very compact design are still considered impossible in the machines of the state of the art. The sludge pulp of industrial origin with a high content of fine solids could be purified to such an extent with a centrifuge of the invention that results in a degree of separation of 95% were obtained. A machine designed for the throughput of 40 l/min results at the relatively low rotation speed of 930 rpm in a centrifugal acceleration of about 360 g and has therefore merely an outer diameter of 1.3 m and a height of 0.9 m.

The centrifuge requires a relatively low drive power. It is very safe to operate due to the missing discharge arrangements

provided with automatically operated closures. The servicing and cleaning are easy to carry out because the rotor 3 is easily accessed from the outside through service openings that can be resealed and the discharge valves 45 as well as the end pieces 4 can be detachably connected to the field spider 30 and, in this way, can be removable or exchangeable.

/15

The releasability of the funnel-shaped end pieces 4 is especially also of importance for the conversion or adaptation of the settling chambers to another mixture. A funnel-shaped end piece with another funnel inclination can be installed, which exchanges the flow-guiding device for another cell formation, and the inflow pipe is exchanged for another one having another length.

The invention is of course not limited to the exemplary embodiment shown in Figs. 1 and 2. It is conceivable in this way to produced the housing and the rotor of the centrifuge in another way than the welding construction. The settling chambers can be configured as one piece, and they can be partitioned by built-in components of another kind into a multitude of flow channels, for example, by ring-shaped partition walls arranged concentrically with respect to the inflow pipe in connection with radial partition walls, by means

of grid-like crossing partition walls, flow channels formed by bundles of thin pipes, by transverse walls in the form of sieves or by transverse walls in the form of conical disks arranged one after the other, as is usual in separators.

/16

Patent Claims:

1. A centrifuge for separating and eliminating solids from mixtures of solids and liquids such as, for example, wastewater of community or industrial origin, sludge pulp, and suspensions that occur during the processing foods and the like, having a vertically mounted rotor that has at least two funnel-shaped, diametrically-opposite settling tanks, whose mouths are equipped with a controllable shut-off device for the outlet opening, wherein the centrifuge includes the following features:

   a) settling chambers (33) comprised by a funnel-shaped end piece and a relatively extended cylindrical cone part with a inlet pipe (35) arranged centrally in the cone part and passing through up the end of this cone part or leading up to the vicinity of this end;

/17

   b) a partition of the annular-cylindrical hollow space formed between the inlet pipe (35) and the inner wall of the

cylindrical cone part of the settling chambers (33) into a multitude of parallel flow channels through planar and/or bent conducting surfaces, partition walls, or the like;

c) outlet openings (5) of the funnel-shaped end pieces (4) of the settling chambers (33), which can be continuously modified to closed in their average cross section.

2. The centrifuge of claim 1, wherein the cylindrical cone part of each settling chamber (33) is detachably connected with its funnel-shaped end piece (4).

3. The centrifuge of claims 1 and 2, wherein the centrifuge has exchangeable inflow pipes (35).

4. The centrifuge of claims 1 to 3, wherein a double cone-shaped drawbar (39) is arranged coaxially within each settling chamber (33) ahead of the mouth of the inflow pipe (35) in such a way that said drawbar points with the tip of its more slender cone part toward the pipe mouth.

/18

5. The centrifuge of claims 1 to 4, wherein the annular-cylindrical space extending between the inflow pipe (35) and the inner wall surface of the settling chamber (33) is partitioned evenly into annular sectors by radial walls (36).

6. The centrifuge of claim 5, wherein the annular sectors are partitioned by parallel transverse walls (37) into sections of about the same width.

7. The centrifuge of claim 6, wherein the parallel transverse walls are formed by sections of concentric pipes.

8. The centrifuge of claims 4 to 7, wherein the radial walls (36) support the double cone-shaped area (39) with their area that penetrates into the interior of the funnel-shaped end piece (4).

9. The centrifuge of claims 4 to 8, wherein the flow-conducting installation forms an independent unit that is pushed onto the inflow pipe (35) and consists of the radial walls (36, 38), the transverse walls (37), and the drawbar (39).

/19

10. The centrifuge of claim 9, wherein the flow-conducting installation and the inflow pipe (35) form one independent constructional unit.

11. The centrifuge of claims 9 and 10, wherein the flow-conducting installation is made of plastic.

12. The centrifuge of claims 1 to 12, wherein the outflow openings of the funnel-shaped end piece (4) are formed by detachably fixed, pneumatically or hydraulically actuated

discharge valves (45), which are already known, and having a pipe-shaped elastic insert (48).

13. The centrifuge of claim 12, wherein an electropneumatic or electrohydraulic control device is provided for the program control of the discharge valve (45).

14. The centrifuge of claims 12 and 13, wherein the pressurized means is fed to the discharge valves (45) via a control valve (47) installed at the lower end of the shaft (2), through the shaft and the support and distribution disk (50) supported by the shaft, to which the feed pipes (46) are connected.

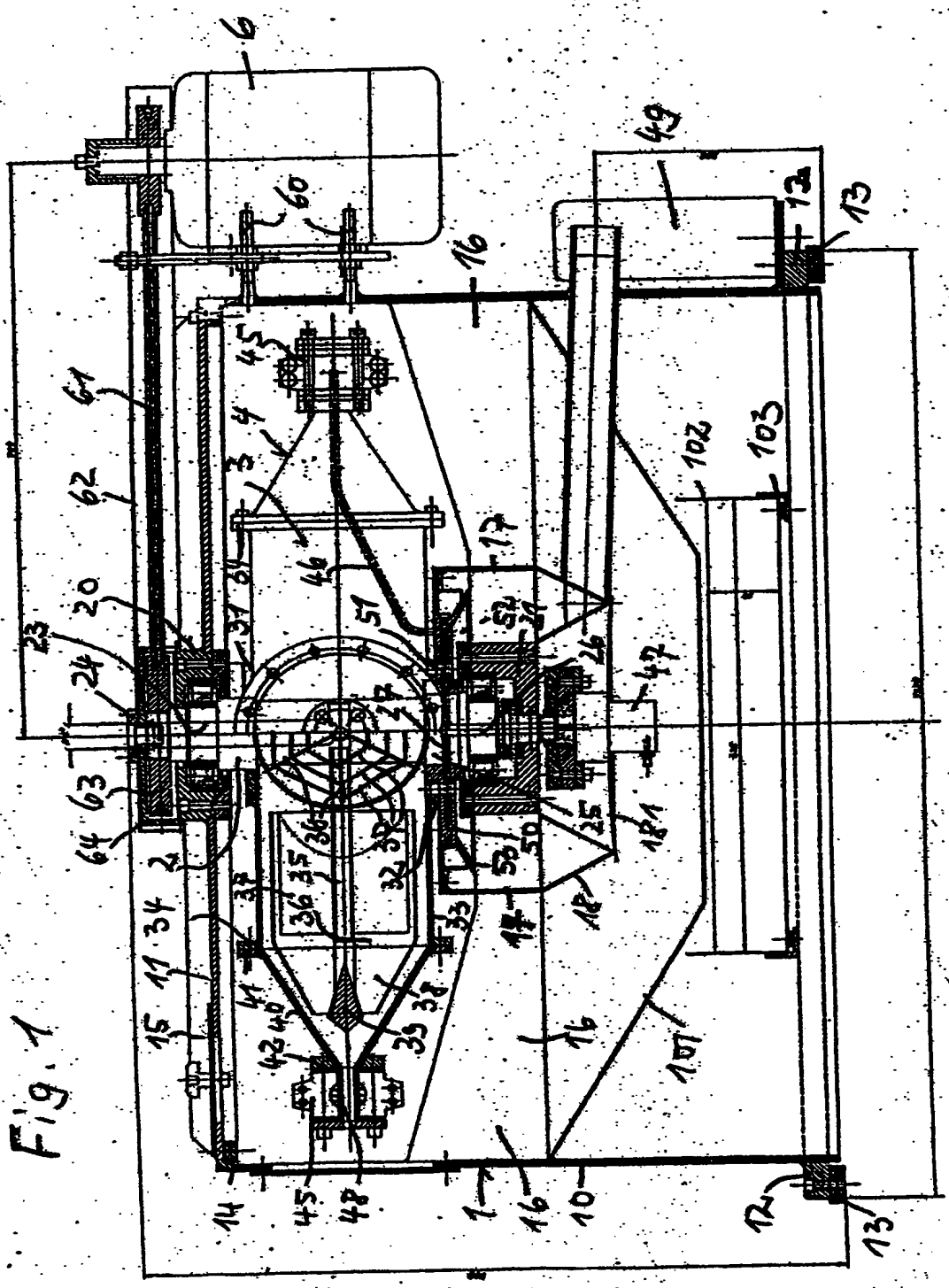

Fig. 1

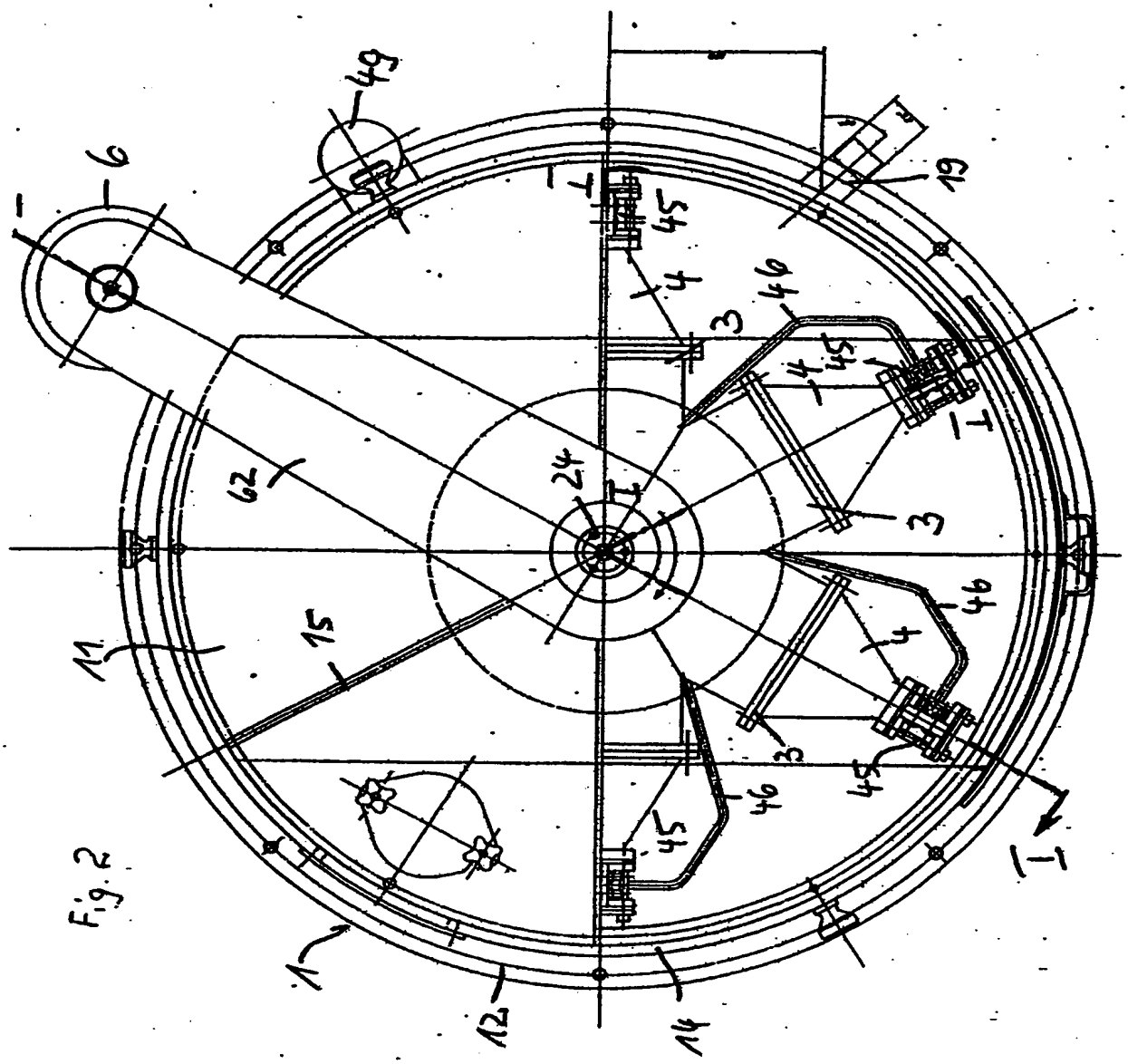

Fig. 2